more irregular. The character of these cells is also very similar to that in the cycads, where the sheath cells right and left of the centripetal xylem are similarly pitted. It is very different from that described by Dr. STOPES for *C. principalis*. She states that the sheath of this form is composed of two parts, an inner of long and slender elements and an outer of short and large ones, both with bordered pits.[33] Recently Miss BENSON[34] has described a form (*C. Felicis*), from the Lower Coal measures of England, with a much less definitely differentiated inner sheath. LIGNIER considers that the "bois diaphragmatique" which he has described corresponds to this "inner sheath" in both these forms. If this conclusion is correct, and there seems little doubt that it is, then his form and that of Miss BENSON have less specialized and more cycadean sheaths than that of *C. principalis*. The bundles of these two forms would thus stand nearer to the *Poroxylon* type, of the detailed structure of which SCOTT in his *Studies in fossil botany* (p. 508) says it is "in fact, that of a cycad." It is interesting to note, in passing, that JEFFREY has chosen the specialized *principalis* type for comparison with *Prepinus* and the Abietineae, while the other is in substantial agreement with the araucarian leaf bundle.

LIGNIER describes at some length the differentiation of certain glandular cells within the bundle sheath. The scelerenchymatous strands above and below the bundle differentiate early, and the mesophyll as well. The cells of the latter have an abundant "protoplasme chlorophyllien probablement accompagné d'hydrates de carbone." The palisade consists ultimately of two or three layers of cells. The epidermis was very poorly preserved and afforded no new data. The bundles were seen to dichotomize, as in ordinary cordaitean leaves, though LIGNIER says that the division does not occur in the same way as STOPES has described in the case of *C. principalis*.

The type of leaf LIGNIER has described is very similar to that of the living broad-leaved forms of the Araucarineae.—R. B. THOMSON.

Water requirement of plants.—BRIGGS and SHANTZ[35] have conducted a series of experiments upon the water requirements of certain crop plants and obtained results which are important not only in determining the most economical plants to cultivate in semi-arid regions, but also in indicating a profitable line of purely ecological research with the natural vegetation of various habitats. The term "water requirement" indicates the ratio of the weight of water absorbed by a plant during its growth to the dry matter produced. The exhaustive review of the literature of the subject will be of great service to all interested in this and allied problems, and demonstrates the fact that while a considerable number of experiments have been performed by a number of

[33] New Phytol. **2**: *pl. 9. fig. 6.* 1903. [34] Ann. Botany **26**:201–207. 1912.

[35] BRIGGS, L. J., and SHANTZ, H. L., The water requirements of plants. I. Investigations in the great plains in 1910 and 1911. II. A review of the literature. U.S. Dept. Agric., Bur. Plant Ind. Bulls. 284 and 285. pp. 49 and 96. 1913.

workers, the methods employed have as a rule been crude and inexact, leading to much uncertainty in the results. Still it is evident that there was an increase in the water requirement when the soil moisture content approached either extreme; when the soil was deficient in any plant food element; when the amount of soil used in the experiment was small; and when shading of the plants occurred. Atmospheric conditions profoundly affected the water requirement, being greater in dry than in moist air.

The extensive experiments of the present investigators in 1910 and 1911 were conducted at Akron, Colo., with plants grown in water-tight pots containing about 115 kilos of soil each, so sealed that the loss of water was limited to that resulting from the transpiration of the plants, water being added as required. Among other results, it was found that wheat consumed an average of 507 kilos of water for each kilo of dry weight produced, and taking this as the standard (100), the relative water requirements of certain other plants were as follows: alfalfa 211; rye 143; oats 122; barley 106; potato 88; maize 73; sorghum 60; millet 54; and such weeds as *Amaranthus retroflexus* and *Salsola pestifer* 63. These results would indicate the great suitability of sorghum and millet for semi-arid regions. The bulletins contain a mass of detail and much additional data valuable to students of the agriculture and ecology of the great plains.—GEO. D. FULLER.

Agriculture on acid lands.—It has long been known that moors and heaths have acid soil, and many ecological classifications, such as that of WARMING, regard acidity as the chief determining factor of the vegetation. In several interesting and important papers, COVILLE[36] has given the results of some experiments that should almost revolutionize certain phases of agricultural practice. As is well known, various species of *Vaccinium* and *Gaylussacia* are commonly sold in the markets as blueberries and huckleberries, and yet are not cultivated, as are most other commercial fruits. Many attempts have been made to cultivate these berries, and their failure is attributed by COVILLE to the fact that their cultivation has been attempted in rich garden soil. Ordinary cultivated plants, such as alfalfa or roses, grow well in rich garden soil and poorly in peat, unless the acidity of the latter is neutralized by lime. The blueberry, on the other hand, grows poorly in garden soil, thrives in peat, and grows poorly in peat neutralized by lime. After describing the root fungi and their probable rôle in making nitrogen available, the author gives directions for germinating and growing blueberries, showing that fruiting plants can be

[36] COVILLE, F. V., Experiments in blueberry culture. U.S. Bur. Plant Ind. Bull. 193. pp. 100. *pls. 18. figs. 31.* 1910.

———, The formation of leaf mold. Jour. Wash. Acad. Sci. 3:77–89. 1913.

———, Directions for blueberry culture. U.S. Dept. of Agric. Circular 122. pp. 11. 1913.

———, The agricultural utilization of acid lands by means of acid-tolerant crops. U.S. Dept. of Agric. Bull. 6. pp. 13. 1913.